

Functional burrow morphology of *Laomedea healyi* (Crustacea: Decapoda: Thalassinidea) in Western Port Bay, Victoria

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Abstract

This study investigated the burrow morphology of the mud shrimp, *Laomedea healyi* Yaldwyn & Wear, in stands of mangrove in Western Port Bay, Victoria. Burrow structure was described from resin casts. *L. healyi* burrows extended further horizontally than vertically and burrows were constructed around the pneumatophores that densely penetrate the sediment at the base of the mangrove trees. Burrows had multiple surface openings, several of which were circular and constricted and others that were oval shaped, connected to a single vertical or sloping main tunnel. The tunnels had a sub-circular cross section with smooth floors and rough walls and roofs and tunnel diameters were considerably larger than the inhabitant. Bulbous terminal chambers were present but did not contain plant material. The characteristic features of *L. healyi* burrows indicate that the species is most likely a deposit feeder. (*The Victorian Naturalist* 128 (1) 2011, 4-10).

Key words: Thalassinidea, Laomedidae, *Laomedea healyi*, burrow morphology

Introduction

Thalassinidean shrimp inhabit marine intertidal and subtidal soft sediment environments and construct burrows that they use for shelter, reproduction and feeding. Burrow morphology is species-specific (Suchanek 1985) and differences in burrow structure have been linked to differences in trophic mode (Griffis and Suchanek 1991; Nickell and Atkinson 1995). A typical burrow of a filter/suspension-feeding species is U-shaped with a circular tunnel cross-sections and a close fit between size of the animal (width of the carapace) and tunnel diameter (Nickell and Atkinson 1995). These features assist filter/suspension feeding by facilitating current generation and efficient flow of water within the burrow (Nickell and Atkinson 1995). A typical burrow of a seagrass/algae-harvesting species has holes without mounds, oblique tunnels which allow access to the sediment surface and deep chambers for storage of plant material (Nickell and Atkinson 1995). A typical burrow of a deposit/detritus-feeding species has surface mounds where processed sediment is ejected, small, circular openings for current generation, and a deep, tightly layered lattice of tunnels and chambers where the species 'mines' the deposit (Nickell and Atkinson 1995). If a deposit-feeding species relies on organic material from the sediment surface, burrow openings and tunnels

will be sub-circular as the species 'bulldozes' sediment between the surface and the burrow (Nickell and Atkinson 1995).

Burrow structure also is influenced by the localised sediment environment. Berkenbusch and Rowden (2000) found that the species *Callianassa filholi* constructs deeper, wider burrows in sediments with lower organic content. Thalassinidean burrows constructed in sand generally penetrated further into the sediment than burrows constructed in mud, possibly to retain larger volumes of water and prevent desiccation and hypoxia (Griffis and Chavez 1988). The shape of *Callianassa pontica* burrows was more irregular in fine sand than in coarse sand, where burrows had simple tunnels and enlarged chambers (Griffis and Suchanek 1991). Structural complexity of the sand or mudflat also affects burrow structure, with the burrows of *Nihonotrypaea petalura* found to wind around boulders or cobbles buried in the sediment (Shimoda and Tamaki 2004).

The burrowing ecology of thalassinideans has been well documented on open mudflats (for example, Dworschak and Rodrigues 1997) and in mangrove channels (Dworschak and Ott 1993; Felder 2001), but burrows within stands of mangroves have received little attention. Sediments associated with mangrove trees are

penetrated by subsurface roots and pneumatophores, thereby creating a complex environment to burrow in. Structural characteristics of crab burrows, such as volume and shape, can be influenced by the biomass of underlying mangrove roots and pneumatophores (Lim and Heng 2007; Berti *et al.* 2008; Katrak *et al.* 2008), with some species specifically selecting regions with pneumatophores for burrow construction (Lim and Rosaih 2007). It is likely that thalassinidean burrow structure also would be affected in a similar way.

Laomedea healyi Yaldwyn & Wear (Decapoda: Thalassinidea: Laomedidae) is distributed intertidally along the eastern Australian coast, from northern Queensland through to central Victoria, including Western Port Bay, and occurs most frequently in mangrove habitats (Yaldwyn and Wear 1972; Poore and Griffin 1979). While previous studies have examined the burrow structure and trophic mode of other genera within the family Laomedidae, little is known about the burrow structure of species in the genus *Laomedea*. Casts of *L. astacina* burrows are documented in Ohshima (1967) and Utashiro (1973) and resemble the burrows of the laomediid *Jaxea nocturna*. *Jaxea nocturna* constructs burrows with multiple entrances that link to a gently sloping main tunnel with a sub-circular cross-section (Pervesler and Dworschak 1985; Nickell and Atkinson 1995). *Axianassa australis* is a laomediid that builds more complex burrows with tight corkscrew-like spiral sections (Dworschak and Rodrigues 1997; Felder 2001). The aim of this study was to investigate the structure and function of *L. healyi* burrows.

Methods

Field sites

Western Port Bay is located approximately 50 km south east of Melbourne, Australia (37°45'S, 144°58'E) and is the second largest bay in Victoria (Marsden *et al.* 1979). Approximately 40% of the 680 km² bay is intertidal (Bird 1986), with sediment consisting of clay, silt, fine sand and shell beds (Ross 2000). The field sites, Warneet and Hastings, are located on the northern and western coast respectively (Fig. 1). Both field sites are characterised by stands of the mangrove *Avicennia marina* (Forsk.) Vierh. fringed by sand and mudflats.

Burrow morphology

The burrows of *L. healyi* were cast *in situ* using epoxy resin (Huntsman International LLC Araldite Kit K3600). The resin (3:1 ratio of resin to hardener) was mixed on site. Plastic collars were placed around the openings to funnel the resin, which was left to set for 48 hr. Once set, the casts were removed by hand and rinsed. Eight casts were made at Warneet between October and December 2006, and seven casts were made at Hastings in January 2007. All casts were returned to the laboratory for analysis. Once the casts had dried thoroughly, excess sediment was removed with a toothbrush. Dimensions of the casts were measured using a tape measure, calipers and an electronic balance. Surface area of the burrow was estimated by wrapping the cast in a single layer of aluminium foil of known weight per unit area (Atkinson and Nash 1990; Bird and Poore 1999). Volume was estimated by dividing the cast weight by the density of the resin/hardener mixture (1.055 g/cm³) (Rowden and Jones 1995; Bird and Poore 1999). To estimate the average tunnel width and height for each cast, all sections of tunnel were measured at 5 cm intervals and an average calculated. The carapace width of any individuals trapped within the burrow casts were measured using callipers. Five chambers were sectioned with a circular saw to reveal if chambers were empty or were used to store rubble or vegetation.

Results

Eight complete casts of the burrows of *L. healyi* were recovered during this study and morphometric data for those casts are given in Table 1. The following descriptions of the burrows of *L. healyi* are based on all complete casts and an additional seven incomplete casts from both sites.

Laomedea healyi burrows generally extended further horizontally than they did vertically and burrow depth averaged 28 cm (Table 1). Pneumatophores regularly protruded through the casts, and tunnels were constructed around this plant material (Fig. 2). Burrows consisted of between one and five surface openings connected to a single main tunnel, which generally led deeper into the sediment either vertically or at an oblique angle (Table 1; Fig. 2). Surface shafts and openings were rarely cast well, but



Fig. 1. Map of Western Port bay, south-eastern Australia, showing the location of the field sites, Warneet and Hastings.

two types of surface openings were identified during collection of *L. healyi* for an associated study. Individuals were collected using a bait pump from small, round holes (approximately 5 mm diameter) and larger oval surface openings (approximately 8 mm diameter). The tunnels had a sub-circular cross section and whilst the floors were relatively smooth, the walls and roofs were rough (Fig. 2). Bulbous chambers often were found at the end of the main tunnel (Fig. 2) but did not contain plant material. This species shows a poor animal: burrow fit, with an average ratio of 1:2.3 (shrimp carapace width: tunnel width) calculated from the individuals found embedded in the resin.

Discussion

Laomedea healyi burrows extended greater horizontally than vertically and burrows were constructed around pneumatophores that densely penetrate the sediment at the base of the mangrove trees. Burrows were most similar to those reported for the laomediid *Jaxea nocturna* (Pervesler and Dworschak 1985) and there was no evidence of the tight spirals observed in the burrows of *Axianassa australis* (Dworshak and Rodrigues 1997).

In Western Port Bay, the root system of *Avicennia marina* mangrove trees comprises 62% of the plant's biomass (Clough and Attiwill 1982) so the sediments surrounding the mangrove trees contain densely-spaced pneumatophores and a fibrous root mat. Burrows of *L. healyi* were constructed around the pneumatophores and roots influencing the overall shape of the burrow. A burrow inhabited by both *Sesarma messa* and *Alpheus* cf. *macklayi* cast in a *Rhizophora* spp. mangrove forest was closely associated with mangrove roots in a similar fashion (Stieglitz *et al.* 2000). Other types of physical structure in habitats are known to affect crustacean burrows. The burrows of *Nilonotrypaea petalura* were wrapped around boulders and cobbles and the species could not maintain burrow integrity without them (Shimoda and Tamaki 2004). Mangrove roots do not appear to be a critical factor in structuring burrows of *L. healyi* because the species also is found in open mudflat environments (Ngoc-Ho 1997). This could be confirmed by a comparison between burrows of *L. healyi* in mangroves and on the open mudflat. Shimoda and Tamaki (2004) suggested that habitat complexity on boulder/cobble beaches offered *N. petalura* protection from predators such as wading birds. The habitat complexity in the mangrove environment could offer similar protection for *L. healyi*.

Laterally extensive burrows allow the inhabitant to readily access surface-derived food sources, such as plant material or particulate organic matter (Suchanek 1985). It is most likely that *L. healyi* would be collecting particulate organic matter rather than plant material because terminal chambers showed no storage of plants. Numerous burrow openings at the surface would increase the success of catching this valuable food source (Nickell and Atkinson 1995). Oblique tunnels and sub-circular tunnel cross-sections are also features indicative of surface access (Nickell and Atkinson 1995), although sub-circular tunnels could also result from sediment processing. Nickell and Atkinson (1995) suggested that the subcircular cross-section of tunnels combined with sloping floors results from continual activity: walking, feeding and bulldozing. *Jaxea nocturna* was observed to bulldoze sediment around its burrow and out the burrow entrance at night. This

Table 1. Dimensions of selected casts of burrows of *Laomedea healyi* collected from Warneet and Hastings.

Site	Cast no.	No. of openings	Depth (cm)	Horizontal extension (cm)	Mean width (mm)	Tunnel height (mm)	Surface area (cm ²)	Volume (cm ³)
Warneet	W1	3	45	23	22	17	1617	308
	W2	4	30	22	19	16	1438	267
	W3	3	18	44	29	21	2500	657
	W4	1	34	16	25	15	1192	235
	W5	5	14	29	24	16	950	290
Hastings	H1	4	21	30	13	10	838	229
	H2	3	39	41	29	23	1854	800
	H3	4	23	21	24	18	1000	387
Mean \pm SD		3 \pm 1	28 \pm 11	28 \pm 10	23 \pm 5	17 \pm 4	1423 \pm 558	397 \pm 214

bulldozing action created the crenate shaped burrow openings as sediment was pushed out of the burrow (Nickell and Atkinson 1995). Oval shaped openings were observed in *L. healyi* burrow entrances, so similar behaviour would be expected by this species. The burrows of *A. australis* also have a sub-circular cross-section and sloping floors, and marks on the burrow floor are consistent with bulldozing (Dworschak and Rodrigues 1997). Similar to *J. nocturna* and *A. australis*, *L. healyi* had a poor animal-to-burrow fit, which is further evidence of bulldozing behaviour and deposit feeding habit (Dworschak and Rodrigues 1997). A circular tunnel cross-section and tight animal-to-burrow fit (both features of filter-feeding thalassinidean burrows and not present in *L. healyi* burrows) facilitates efficient current generation and water flow through the burrow (Nickell and Atkinson 1995).

The majority of surface openings of *L. healyi* were constricted. The major function of a constricted burrow opening is to accelerate the current of water being ejected from the burrow thereby improving burrow water circulation (Bromley 1990). It has been suggested that constricted surface openings of thalassinidean burrows can be enlarged at times to allow surface access for collection of organic-rich surface sediment (Kinoshita and Itani 2005). It is known that *J. nocturna* moves onto the surface at night to collect material from the sediment surface (Nickell and Atkinson 1995). Behavioural observations of *L. healyi* in aquaria or in the field are needed to examine when the

species accesses the surface and what activities take place.

Sediment is processed by thalassinideans when collecting food or when burrows are expanded or repaired (Griffis and Suchanek 1991). The presence of chambers in the burrows of *L. healyi* is also indicative of sediment processing by the shrimp, and are used by some species to store either coarse material, such as rubble or plant material, as a food source (Griffis and Suchanek 1991). A combination of surface access, sediment processing and storage burrow features in *L. healyi* burrows indicate that food sources probably include surface or subsurface sediment or organic material on the sediment surface (Nickell and Atkinson 1995). No plant material was found stored in chambers and no evidence of plant matter was found in the gut contents, therefore it is unlikely that this species collects food such as drift algae or seagrass from burrow openings to eat directly or store in chambers to facilitate microbial growth (Abed-Navandi *et al.* 2005). Chambers in *L. healyi* burrows had rough walls and floors (unlike the compacted floors of other parts of the burrows) which may indicate that these regions may have been excavated for deposit feeding.

The burrows of *L. healyi* cast in this study were similar in depth to burrows of other deposit-feeding thalassinideans inhabiting Western Port Bay (*Biffarius arenosus* and *Trypaea australiensis*, Bird and Poore 1999, Stapleton *et al.* 2001) but shallower than has been reported for other species within the family Laomedii-

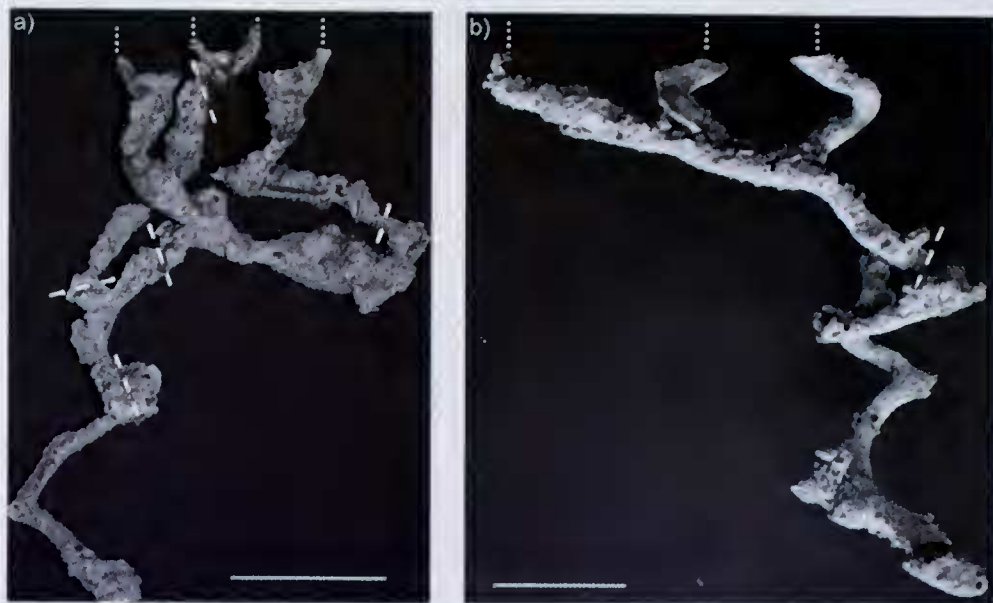


Fig. 2. Casts of *Laomedea healyi* burrows from Western Port: a) Cast W2 and b) Cast H2. Scale bar represents 10 cm. The dotted line represents the extension of the burrow to the surface. The dashed line represents the location of mangrove root material.

dae. Casts of *J. nocturna* have been found to extend to a depth of 80–90 cm (Pervesler and Dworschak 1985; Nickell and Atkinson 1995), and *A. australis* burrows have been shown to reach depths of 130 cm (Dworschak and Rodrigues 1997). The sediments associated with stands of mangroves are in a permanent hypoxic or even anoxic state (Hogarth 1999). It has been argued that U-shaped thalassinidean burrows are flushed well but the complex burrows of deposit-feeding species restrict flushing, resulting in severe hypoxia (Astall *et al.* 1997); however, in mangrove stands, the surface water slope of the incoming tide facilitates flushing in multi-holed burrows (Stieglitz *et al.* 2000). A burrow shared by *Sesarma messa* and *Alpheus cf macklay* was fully flushed by passive irrigation with the incoming tide (Stieglitz *et al.* 2000). This flushing would occur to some extent in *L. healyi* burrows, ameliorating the severity of the anoxic conditions. *Jaxea nocturna* has a high sulphide tolerance and burrows to a depth of 92 cm (Johns *et al.* 1997). *Axianassa australis* also burrows to a depth of 130 cm and it has been suggested that the species burrows into the deep hypoxic zone (Felder 2001). Bur-

rows of *L. healyi* are shallower, so this species may have a lower tolerance to anoxia and sulphide than *J. nocturna*. Shallower burrows with well connected tunnels also would flush more thoroughly during a tidal influx.

In conclusion, analysis of burrow structure indicates that *L. healyi* is most likely a deposit feeder that collects organic matter from above and below the sediment surface. Further investigation into diurnal behavioural patterns will reveal if the species ventures onto the sediment surface at night (similar to *Jaxea nocturna*). A comparison of *L. healyi* burrows constructed on the open mudflat and beneath mangrove trees will reveal the extent to which the presence of subsurface mangrove roots affects burrow structure.

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References

- Abed-Navandi D, Koller H and Dworschak PC (2005) Nutritional ecology of thalassinidean shrimps constructing burrows with debris chambers: The distributions and use of macronutrients and micronutrients. *Marine Biology Research* **1**, 202-215.
- Astall CM, Taylor AC and Atkinson RJA (1997) Behavioural and physiological implications of a burrow-dwelling lifestyle for two species of upogebiid mud-shrimp (crustacean, thalassinidea). *Estuarine Coastal and Shelf Science* **44**, 155-168.
- Atkinson RJA and Nash RDM (1990) Some preliminary observations on the burrows of *Callianassa subterranea* (Montagu) (Decapoda: Thalassinidea) from the west coast of Scotland. *Journal of Natural History* **24**, 403-413.
- Berkenbusch K and Rowden AA (2000) Intraspecific burrow plasticity of an intertidal population of *Callianassa filholi* (Crustacea: Decapoda: Thalassinidea) in relation to environmental conditions. *New Zealand Journal of Marine and Freshwater Research* **34**, 397-408.
- Berti R, Cannicci S, Fabbri S and Innocenti G (2008) Notes on the structure and the use of *Neosartium meinerti* and *Cardisoma carnifex* burrows in a Kenyan mangrove swamp (Decapoda Brachyura). *Ecology, Evolution and Evolution* **20**, 101-113.
- Bird ECF (1986) Mangroves and intertidal morphology in Westernport Bay, Victoria, Australia. *Marine Geology* **69**, 251-271.
- Bird FL and Poore GCB (1999) Functional burrow morphology of *Biffarius arenosus* (Decapoda: Callianassidae) from southern Australia. *Marine Biology* **134**, 77-87.
- Bromley RG (1990) Trace fossils: biology and taphonomy. (Unwin Hyman: London)
- Clough BF and Attiwill PM (1982) Primary productivity of mangroves. In *Mangrove Ecosystems in Australia: Structure, function and management*, pp. 213-222. (Australian Institute of Marine Science/ Australian National University Press: Canberra)
- Dworschak PC and Ott JA (1993) Decapod burrows in mangrove-channel and back-reef environments at the Atlantic Barrier Reef, Belize. *Ichnos* **2**, 277-290.
- Dworschak PC and Rodrigues SDA (1997) A modern analogue for the trace fossil *Gyrolithes*: burrows of the thalassinidean shrimp *Axianassa australis*. *Lethaia* **30**, 41-52.
- Felder DL (2001) Diversity and ecological significance of deep-burrowing macrocrustaceans in coastal tropical waters of the Americas (Decapoda: Thalassinidea). *Interciencia* **26**, 440-449.
- Griffis RB and Chavez FL (1988) Effects of sediment type on burrows of *Callianassa californiensis* Dana and *C. gigas* Dana. *Journal of Experimental Marine Biology and Ecology* **117**, 239-254.
- Griffis RB and Suchanek TH (1991) A model of burrow architecture and trophic modes in thalassinidean shrimp (Decapoda: Thalassinidea). *Marine Ecology Progress Series* **79**, 171-183.
- Hogarth P (1999) *The biology of mangroves*. (Oxford University Press: Oxford)
- Johns AR, Taylor AC, Atkinson RJA and Grieshaber MK (1997) Sulphide metabolism in thalassinidean crustacea. *Journal of the Marine Biological Association of the United Kingdom* **77**, 127-144.
- Katrak G, Dittmann S and Seuront L (2008) Spatial variation in burrow morphology of the bud shore crab *Holograpsus haswellianus* (Brachyura, Grapsidae) in South Australian saltmarshes. *Marine and Freshwater Research* **59**, 902-911.
- Kinoshita K and Itani G (2005) Interspecific differences in the burrow morphology between the sympatric mud shrimps, *Austinogebia narutensis* and *Upogebia issaeffi* (Crustacea: Thalassinidea: Upogebiidae). *Journal of the Marine Biological Association of the United Kingdom* **85**, 943-947.
- Lim SSL and Heng MMS (2007) Mangrove micro-habitat influence on bioturbative activities and burrow morphology of the fiddler crab, *Uca annulipes* H. Milne Edwards, 1873 (Decapoda, Ocypodidae). *Crustaceana* **80**, 31-45.
- Lim SSL and Rosiah A (2007) Influence of pneumato-phores on the burrow morphology of *Uca annulipes* H. Milne Edwards, 1837 (Brachyura, Ocypodidae) in the field and in simulated mangrove micro-habitats. *Crustaceana* **80**, 1327-1338.
- Marsden MAH, Mallett CW and Donaldson AK (1979) Geological and physical setting, sediment and environments, Western Port, Victoria. *Marine Geology* **30**, 11-46.
- Ngoc-Ho N (1997) The genus *Laomedea* De Haan, 1841 with description of a new species from Vietnam (Crustacea, Thalassinidea, Laomedidae). *Zoosystema* **19**, 729-747.
- Nickell LA and Atkinson RJA (1995) Functional morphology of burrows and trophic modes of three thalassinidean shrimp species, and a new approach to the classification of thalassinidean burrow morphology. *Marine Ecology Progress Series* **128**, 181-197.
- Ohshima K (1967) Burrows of Japanese Thalassinidea. *Chikyu kagaku* **21**, 11-18.
- Pervesler P and Dworschak PC (1985) Burrows of *Jaxea nocturna* NARDO in the Gulf of Trieste. *Senckenbergiana maritima* **17**, 33-53.
- Poore GCB and Griffin DJG (1979) The Thalassinidea (Crustacea, Decapoda) of Australia. *Records of the Australian Museum* **32**, 1-56.
- Ross R (2000) *Mangroves and Salt Marshes in Westernport Bay, Victoria*. (Arthur Rylah Institute for Environmental Research: Melbourne)
- Rowden AA and Jones MB (1995) The burrow structure of the mud shrimp *Callianassa subterranea* (Decapoda: Thalassinidea) from the North Sea. *Journal of Natural History* **29**, 1155-1165.
- Shimoda K and Tamaki A (2004) Burrow morphology of the ghost shrimp *Nihonotrypaea petalura* (Decapoda: Thalassinidea: Callianassidea) from western Kyushu, Japan. *Marine Biology* **144**, 723-734.
- Stapleton KL, Long M and Bird FL (2001) Comparative feeding ecology of two spatially co-existing species of ghost shrimp, *Biffarius arenosus* and *Trypaea australiensis* (Decapoda: Callianassidae). *Ophelia* **55**, 141-150.

- Stieglitz T, Ridd P and Müller P (2000) Passive irrigation and functional morphology of crustacean burrows in a tropical mangrove swamp. *Hydrobiologia* 421, 69–76.
- Suchanek TH (1985) Thalassinid shrimp burrows: Ecological significance of species-specific architecture. In Proceedings of the 5th International Coral Reef Congress, Papeete, Tahiti, pp 205–210.
- Utashiro T (1973) Study of a tidal flat (3). Interesting habitat and lebensspuren. *Kokudo-to-Kyoiku* 4, 134–139.
- Yaldwyn JC and Wear RG (1972) The Eastern Australian burrowing mud-shrimp *Laomedea healyi* (Crustacea, Macrura, Reptantia, Laomedidae) with notes on larvae of the genus *Laomedea*. *Australian Zoologist* 17, 126–141.

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One Hundred Years Ago

A CYCLE TRIP THROUGH EAST GIPPSLAND

By H. B. WILLIAMSON

(Read before the Field Naturalists' Club of Victoria, 12th June, 1911.)

DURING the recent Christmas holidays I took the opportunity of visiting East Gippsland, the Lakes district, and the vicinity of the Snowy River. I wanted to see, in their native habitat, the plants I had become familiar with by means of either dried or freshly-picked specimens sent to me by collectors at Orbost—Messrs. J. Rowe, E. Pescott, and C. H. Grove. I also wished to get a knowledge of the birds of Gippsland.

Leaving Melbourne by early train on Thursday, 29th December last, I arrived at Bairnsdale early in the afternoon. Cycling to Swan Reach, on the Tambo River, 13 miles distant, I found the road good, but uninteresting from a botanist's point of view. On the roadside near Bairnsdale I gathered the Crabgrass, *Eleusine cruciata*, and, in a flooded depression, *Damasonium australe*: Just as I arrived at Swan Reach a little river Steamer was coming down from Mossiface. The bridge was "up", and I was just in time to get a picture showing the steamer passing under the bridge, which had been lifted in two parts by hydraulic pressure. I have seen no prettier river than the Tambo, and I advise anyone who has time when at Bairnsdale to make the trip up to Mossiface.

I made Nowa Nowa for breakfast next morning, getting a lift in a waggonette whose driver wanted company. I could have driven all the way to Orbost with him, but preferred staying to look around till dinner-time. A stream, misnamed Boggy Creek, here flows into an arm of Lake Tyers, which winds up from the beach near Cunninghamham. ... I spent the morning noting the vegetation. It was too late for many of the plants, but nice blooms of *Tristania laurina* and *Trachymene Billardieri* were obtained. *Prostanthera hirtula* also was common, but going off bloom. I collected on the high banks the Oat-grass, *Anisopogon avenaceus*—a tall, coarse species that I had not met with before. The specimens of Kangaroo-grass, *Anthistiria ciliata*, and *Agrostis rudis*, associated with the Oat-grass, were very fine. Some tall shrubs of *Leptospermum attenuatum* grow just behind the hotel, but fruit only was to be found on them. I feel sure the vicinity of this creek during the month of November would yield a fine "bag" to the collector.

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